**CERTIFICATE OF SERVICE**

I, William D. Wallace, hereby certify that I have on this 20th day of June, 1994, caused copies of the foregoing Reply Comments to be delivered via hand delivery (indicated with *) or by U.S. mail, postage-prepaid, to the following:

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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

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| In the Matter of | ) | |
| | ) | |
| Amendment of the Commission's Rules to Establish Rules and Policies Pertaining to a Mobile Satellite Service in the 1610-1626.5 MHz and 2483.5-2500 MHz Frequency Bands | ) | CC Docket No. 92-166 |

# TECHNICAL APPENDIX

## TO REPLY COMMENTS OF

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## TECHNICAL APPENDIX

## SECTION 1

### 1.0 Intraservice Sharing

### 1.1 L-Band Sharing Plan

LQP supports the Commission's proposed division of the 1610-1626.5 MHz band into two portions: 5.15 MHz for the TDMA/FDMA system and 11.35 MHz for the CDMA systems on a shared basis. This method of licensing the service uplink was endorsed, in principle, by all the other LEO applicants. Moreover, the comments of numerous parties, including the CDMA applicants, the radioastronomy community, Mobile Datacom, Inc. and Comsat support either directly or indirectly LQP's proposal that the Commission retain 11.35 MHz for CDMA systems, even if one CDMA system goes into service.

The spectrum division in the L-band service uplink should not be reduced if only one CDMA operator proceeds for the following reasons:

(1) it will facilitate international coordination with other CDMA systems;

(2) it will provide CDMA systems access to adequate spectrum above the radioastronomy allocations to protect radioastronomy operations; and

(3) it will provide sufficient capacity to CDMA systems on the uplink to enable efficient operation of mobile earth stations (MES).

In international coordination, reducing the MSS uplink to be used by CDMA systems will cause immense difficulties in analyzing the sharing situation between U.S. and non-U.S. systems. These difficulties will increase the length and complexity of coordinations and will not provide adequate information to other administrations. For example, non-U.S. systems that might be able to operate compatibly with the U.S. CDMA systems, but not with the FDMA/TDMA system, could be faced with a future impact on their systems if the use of the uplink spectrum is revised. Motorola has repeatedly taken the position that it cannot share spectrum; this would be the case for non-U.S. as well as U.S. systems. The systems of other administrations, as well as U.S. CDMA systems, should not be

exposed to the prospect of a reduction in spectrum in the service uplink. In view of the complex nature of international satellite coordination, especially for non-GSO systems, uncertainty as to the frequencies associated with specific systems could pose an insuperable problem and cause delays in completion of coordination for U.S. systems.

Seven administrations have advance published and/or requested coordination for satellite systems using the 1610-1626.5 MHz band. In addition to the U.S. applicants, INMARSAT,[1] France, Germany, The Netherlands, Indonesia and Tonga have filed with the ITU Radio Registration Board. Furthermore, the Russians recently filed the characteristics of two systems, Signal and ELEKON,[2] which proposed to use spectrum adjacent to this band. Some of these systems may plan to provide service in areas adjacent to the United States such as Canada, Mexico and the Caribbean. Thus, the United States faces a formidable task in coordinating the U.S. systems. This task should not be complicated by the possibility that the spectrum available to various system types in the United States may change.

The need to protect the Radio-Astronomy Service (RAS) also necessitates that CDMA MSS systems have access to sufficient spectrum in the upper part of the 1610-1626.5 MHz band. As discussed at length in Section 2.1 concerning protection of RAS, CDMA MSS systems require access to sufficient spectrum -- at least up to 1620.1 MHz and preferably to 1621.35 MHz -- to provide the continuity of service in the U.S. required by the Commission, while protecting radioastronomy operations. In order to ensure 100 percent continuity of service in the United States, as required by the Commission, CDMA MSS systems require bandwidth in the upper portion of the L-band spectrum. Users which are close to the RAS sites require bandwidth or channel assignments significantly removed in bandwidth from the RAS band. Besides this RAS band, the radioastronomy community has requested an additional protection zone, up to 1615.8 MHz, to protect RAS from out-of-band emissions.

Limiting the TDMA/FDMA system to 5.15 MHz also is supported by Cornell University, the operator of the Arecibo Observatory in Puerto Rico. Cornell points out that the operation of the TDMA/FDMA downlink in the 1613.8-1626.5 MHz band may interfere with the observatory's passive research. Expansion of the TDMA/FDMA operations into additional spectrum could close "another valuable

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[1] While primarily focusing on the 2 GHz band, INMARSAT also reserved the right to utilize the 1.6/2.5 GHz bands.

[2] See Information paper provided by Russia to the ITU-R Task Group 4/5 meeting, June 2-10, 1994.

window to the Universe" even further, according to Cornell.[3] Thus, both the need to protect radioastronomy sites while maintaining fulltime service in the U.S., and the impact on passive radioastronomy research of expanding the frequencies used by the TDMA/FDMA system, provide additional compelling reasons to restrict the TDMA/FDMA system to the 5.15 MHz bidirectional use of the uplink band proposed by the Commission.

As to the third concern, CDMA capacity on the return L-band uplink is interference limited in contrast to the forward S-band downlink capacity which is limited by the power flux density limits of Radio Regulation 2566. The availability of sufficient L-band spectrum is needed by CDMA MSS systems to decrease the interference density of CDMA users. A reduction in uplink spectrum would compress the number of users (and increase noise). Sufficient bandwidth on the uplink will enable better service to the user because the required EIRP from the MES will be reduced. When less power is used, more talk time is available to the user because of lesser demands on the MES battery. To illustrate, in the case of GLOBALSTAR, reducing the uplink bandwidth from 11.35 MHz to 8.25 MHz would increase the average user EIRP by over 100 percent and reduce talk time available by 51 percent.

GLOBALSTAR selected CDMA because of its spectrum efficiency and ability to share the band with other systems. LQP applied for 16.5 MHz in the L-band, and subsequently agreed that this bandwidth could be shared with up to three other CDMA systems. Then, in order to resolve this proceeding and enable the systems to be licensed, LQP accepted the Commission's proposal to designate the upper 5.15 MHz of the L-band exclusively to the TDMA/FDMA systems. However, the designation of a portion of this band to the TDMA/FDMA system takes capacity from the CDMA MSS systems, and impacts system operation. If bandwidth in addition to the 5.15 MHz were assigned to the TDMA/FDMA system in the United States, even more capacity would be lost in the GLOBALSTAR system.

During the MSS Above 1 GHz Negotiated Rulemaking (NRM), the CDMA MSS applicants demonstrated that CDMA systems can provide more user capacity than one or more TDMA systems in the same bandwidth.[4] To constrain the

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[3] Cornell University Comments, at 4-5.

[4] In Section 5 of the Majority Report of IWG-1, it was shown that, when 2, 3, or 4 CDMA MSS systems shared the 16.5 MHz of L-band spectrum, the return link CONUS capacity was approximately 10,000 users with realizable single MSS system capacities from 5000 to well over 10,000 users depending upon the system. Motorola's analysis (p. 47) in its Report on Band Segmentation Sharing indicated

benefits of spectrum-efficient systems such as GLOBALSTAR by reducing uplink spectrum would discourage rather than encourage the development and use of similar technologies.

The imperatives of international coordination, protection of radioastronomy and efficient operation of CDMA MSS systems necessitate that the Commission provide CDMA MSS systems with 11.35 MHz of the L-band spectrum, regardless of the number of U.S. CDMA MSS systems which ultimately are placed in service.

## 1.2 MES Emission Limitations

There are three domains for out-of band emissions and each must be considered separately. These domains are:

(1) Emissions out of the 1610-1626.5 MHz MSS band into the adjacent band above 1626.5 MHz which is allocated to the Maritime Mobile Satellite and Mobile-Satellite Services on a primary basis;

(2) Emissions out of the 1610-1626.5 MHz MSS band into the adjacent band below 1610 MHz which is allocated to the Aeronautical Radio Navigation and Radio Navigation-Satellite Services (ARNS/RNSS) on a primary basis; and

(3) Individual carrier out-of-band emissions within the 1610-1626.5 MHz MSS band at the boundary between CDMA and TDMA for the purposes of coordination.

These domains must be considered separately in order not to overspecify any one domain such that MES terminal design is overly constrained. Further, there is no reason why the high side and low side emission masks must be the same.

For the TDMA operator, the out-of-band emissions take on a special dimension because consideration of the secondary downlink must be included. For the TDMA uplink (Domain 1), Motorola must consider its high side out-of-band emission effects on operations at the 1626.5 MHz boundary. LQP does not seek to address this case, but points out that Motorola should seek coordination with INMARSAT and other users of this band.

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3854 users in 8.25 MHz or 7708 users for a 16.5 MHz comparison. Thus, spectrum allocated to CDMA MSS systems of different design provide about 30 percent more capacity than the TDMA approach.

For the CDMA operators, the uplink out-of-band emissions at 1610 MHz on the low side must be coordinated with ARNS/RNSS. Out-of-band emissions of CDMA near 1610 MHz will need coordination by the CDMA operators. The results of testing now underway and other analyses will need resolution before these out-of-band coordination discussions can take place. Therefore, establishment of the specific out-of-band emissions mask for the lower side below 1610 MHz cannot be specified at this time.[5]

In the 1610-1626.5 MHz band, GLOBALSTAR's 1.23 MHz carrier plus the other MSS applicants' emission mask values close-in to the carrier must be evaluated for determining the value to be utilized for a guard band between TDMA and CDMA. Insufficient information exists to establish these values now. These values can only be established through detailed technical coordination among the applicants licensed as well as testing of MES units. While Motorola seeks to place "IS-95" like values on CDMA operators in its proposed emission mask, it does not at the same time propose values for TDMA. Testing of MES units operating at 1.6 GHz is required to establish the high side emissions close-in to the CDMA carrier and likewise testing of the TDMA signal close-in to the Motorola signal in order to determine the proper separation needed for a guardband. Then, an equitable adjustment for guardband reductions from each segment can be made. Premature establishment of out-of-band emission masks by the Commission would lead to wasted spectrum. Since bandwidth is extremely limited, the Commission should put a premium on not wasting the slightest amount. Therefore, LQP recommends not establishing limits on out-of-band emissions at this time, but instead recommends that this be made part of coordination procedures. Moreover, out-of-band emission mask limitations and values should be placed in the MES blanket licensing procedures and specified in the applications for the MSS user terminals and not in this proceeding.

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[5] LQP has performed some out-of-band emissions testing which are valid for "far out-of-band," i.e., greater than 4 MHz away from the CDMA carrier center frequency. This data has been formally submitted to the Commission for its use in the ECAC Test Program and LQP was the only CDMA operator to do so. This results from the use of a specific test setup which gives values for far out-of-band emissions, not close-in. Further testing of an LQP MES unit will be undertaken soon which will study the close-in values of out-of-band emissions. The values provided to the Commission are regarded to be representative.

### 1.2.1 Introduction to the Emission Limitations near the CDMA/TDMA Boundary

While LQP does not believe that specification of the out-of-band emissions is proper at this time, LQP takes exception to three specific aspects of the Motorola proposal in its NPRM Comments (pp. 50-53) to modify the Commission's Rule 25.202 (f) for MES emission limitations near the CDMA/TDMA boundary in the 1610-1626.5 MHz MSS band. These three aspects are outlined below and expanded upon in subsequent sections. In the following, LQP describes the principles that should govern out-of-band emission and proposes alternative emission masks.

1) *Terrestrial CDMA Mask*--On page 51 of its comments, Motorola states that the mask which it proposes "is consistent with terrestrial terminals being designed by CDMA manufacturers such as QUALCOMM, Inc. and Motorola." The only specification for terrestrial out-of-band emission for CDMA is contained in CTIA standard IS-95. The mask Motorola proposes is far more restrictive than the one in IS-95.

2) *Combined TDMA/CDMA mask*--Motorola proposes one mask applicable to both the wideband CDMA and the narrowband TDMA systems. Because the frequency region of relatively high out-of-band emissions is proportional to the bandwidth of the signal, any such combining of out-of-band emission performance results in extraordinarily relaxed requirements on the narrowband signal, in this case, the TDMA system, and more stringent requirements on the wideband signal, in this case, the CDMA system. This contravenes the fundamental principle that regions of high intermod should be in proportion to the bandwidth of the signal--a principle that Motorola espoused at the NRM proceedings.

3) *Dependence on Antenna Gain*--Motorola proposes that the out-of-band emission be dependent on the gain of the user terminal with larger gain units permitted lower emissions. LQP assumes that the emissions are EIRP numbers, as they usually are, and hence already take into account antenna gain. If that is not true, the mask should be redesigned. That is, the interference should be an EIRP value and independent of antenna gain. Furthermore, the formula Motorola proposes contains an error.

### 1.2.2 Terrestrial CDMA Mask

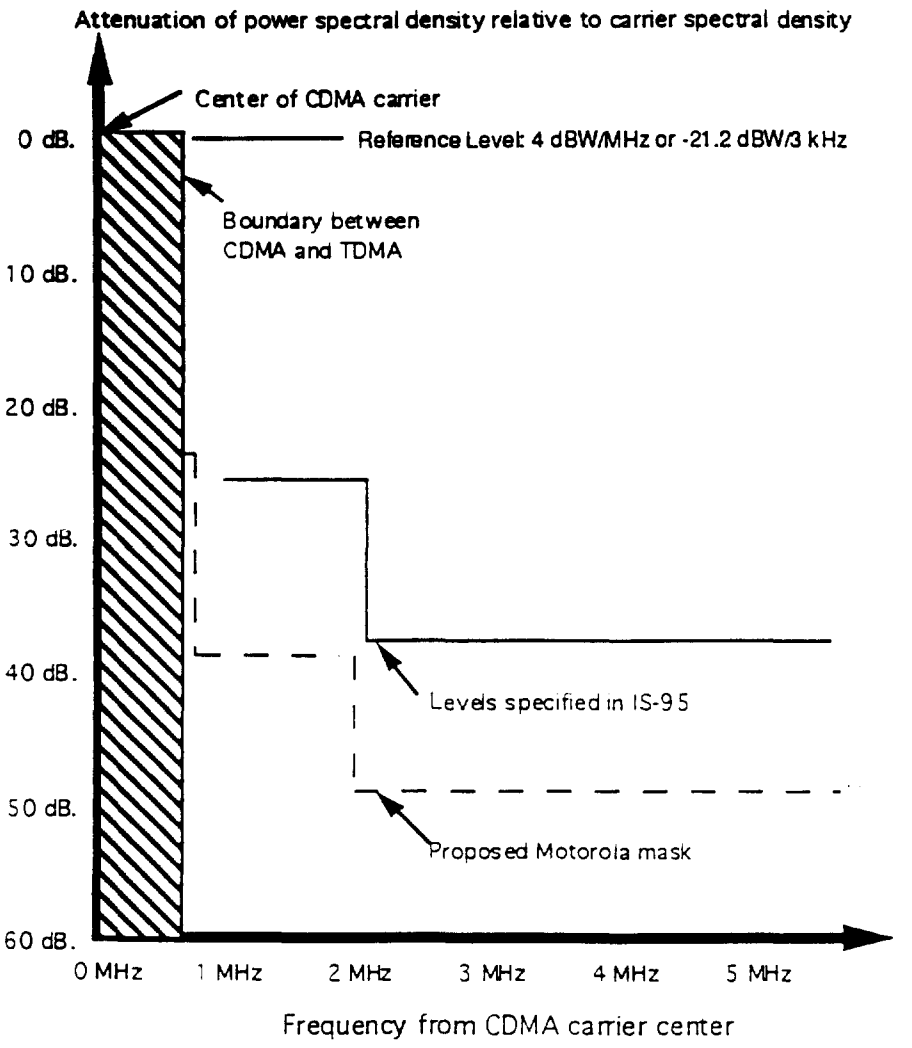
On page 51 of its comments, Motorola states that the mask which it proposes "is consistent with terrestrial terminals being designed by CDMA manufacturers such as QUALCOMM, Inc. and Motorola." The terrestrial out-of-band emission specified for CDMA is contained in CTIA standard IS-95. The relevant portions of the specifications in IS-95 state that:

| | |
|---|---|
| For frequencies greater than 880 kHz from carrier center | Power spectral densities less than -42 dBc/30 kHz |
| For frequencies greater than 1.98 MHz from carrier center | Power spectral densities less than -54 dBc/30 kHz |

It should be noted that IS-95 does not require any attenuation of the 1.25 MHz wide signal within 880 kHz of the carrier center frequency. This appears to be considerably different than Motorola's interpretation of IS-95. Figure 1.2-1 presents a graph of the IS-95 reference mask and the Motorola proposed MES emission limitations at the CDMA/TDMA boundary. Under the assumption of a GLOBALSTAR signal of 4 dBW/MHz power density level (the same maximum power level used in the sharing analysis with GPS and GLONASS in Section 2.2) in the passband and 1.25 MHz bandwidth, the mask Motorola now proposes is at least 10 dB more restrictive. And unless the CDMA carrier center is moved lower in frequency (to, in effect, create an over 200 kHz guardband within the CDMA band segment) the proposed mask would be over 20 dB more stringent in other regions.

# FIGURE 1.2-1
# BOUNDARY (OUT-OF-BAND) EMISSION MASKS

## As Proposed by Motorola and as Specified in IS-95



### 1.2.3 Combined TDMA/CDMA Mask

Motorola proposes one mask to be applied to both CDMA and TDMA systems. Because the frequency region of relatively high out-of-band emissions is proportional to the bandwidth of the signal, any such combining results in extraordinarily relaxed requirements on the narrow band, or in this case, TDMA system. To illustrate this, consider the reports written for the NRM Working Group 1 by the Majority of Active Participants as well as by Motorola on uplink and downlink out-of-band emissions. Both reports illustrate the dependence of out-of-band emission on the bandwidth of transmitted signal. Motorola's proposal for the uplink, in its separate report to the NRM committee (page 16) was as follows:

| Attenuation in dB | Frequency separation |
|---|---|
| 26 | > 0.5b + r/2 through 1.5b |
| 38 | > 1.5b through 2.5b |
| 45 | > 2.5b |

where b is the bandwidth and r is the reference measurement bandwidth (a few kHz).

If Motorola's approach in the NRM were applied to a mobile earth station with the same bandwidth and in-band power spectral density as the CDMA signal, the result is quite close to the IS-95 specifications and much less demanding than the current Motorola proposal.

The Report of the Majority of the Active Participants of IWG-1, as well as the Report of Motorola, proposed the somewhat different mask given below for the downlink:

| Attenuation in dB | Frequency separation |
|---|---|
| 25 | > 0.5b + r/2 through 1.5b |
| 35 | > 1.5b through 3.0b |
| 43 | > 3.0b |

While the numbers in the two proposals differed somewhat, they were both based on the same principle. Both followed accepted practice in allowing for a transition region from the passband to an intermod dominated region, and finally for sufficiently large frequency, a noise floor region. Most important of all, the results were frequency scaled -- i.e., signals of larger bandwidth, b, were permitted proportionately larger frequencies of relatively low attenuation (or relatively high out-of-band emission). That principle is as true for the mobile earth station uplink as the gateway-to-satellite links. Motorola inappropriately proposes to use one

spectral mask to apply to CDMA as well as TDMA, the result is a specification that is difficult for CDMA systems but easy for a TDMA system because Motorola has only 41.67 kHz bandwidth in its signal. All other potential users of this band have proposed wideband CDMA modulation which allows systems to interference share the band. Motorola, the only participant to use narrowband modulation, already is being accommodated by a band segmentation plan. If the out-of-band emission plan put forward by Motorola is adopted, TDMA frequencies can be used right up to the dividing line between the two band segments, but CDMA users would have to locate their carriers hundreds of kilohertz lower than the band edge in order to satisfy the proposed Motorola mask. The inappropriate use of the same mask would deny CDMA systems use of the upper portion of the L-band designated for their use.

### 1.2.4 Dependence on Antenna Gain

Motorola proposes that the out-of-band emission be dependent on the gain of the user terminal with larger gain units permitted lower emissions. LQP assumes that the emissions are EIRP numbers, as they usually are, and hence already take into account antenna gain. The interference should be an EIRP value independent of antenna gain. In examining Motorola's proposed emission requirements for higher gain antennas (Section (h) on page 52), LQP notes a requirement for lower EIRP values from higher gain antennas. LQP also notes that the formulas given, contain the term 10 log(G) where it is stated that G is in units of dBi. The rationale for converting a number to dB which is already in dB was not explained.

### 1.2.5 Objections to Motorola's Proposed MES Emission Limitations

LQP is evaluating several techniques to reduce out-of-band MES emissions for both close-in and distant offsets from the carrier frequency. Both cost and performance objectives are being considered. Establishment of emission limitations at the CDMA/TDMA boundary is premature and should be the subject of coordination among the MSS systems after licenses have been granted. LQP opposes Motorola's proposed MES emission limits for the following reasons:

- The out-of-band MES emissions at the lower band edge to protect GPS have been proposed by the Commission. LQP has proposed emission limits to protect both GPS and GLONASS as part of GNSS.

- MES emissions across the boundary between CDMA and TDMA should be the subject of coordination among the MSS applicants receiving licenses and it is premature to establish rules at this time.

- Emission limitations should be related to the modulation bandwidth of the MES signals on both sides of the CDMA/TDMA boundary rather than the approach proposed by Motorola.

### 1.2.6 Summary of Emission Limitations near the CDMA/TDMA Boundary and Band Edges

Establishment of further MES emission limitations are premature at this time; they should be the subject of coordination among the MSS operators and be addressed in the blanket licensing by the Commission proceeding for MES. However, if the Commission decides to specify an MES emission limitation across the CDMA/TDMA boundary, the Commission should consider:

- Emission limitations on MES units are presently covered by Rule 25.202(f).

- Emission limitations on MES units to protect GNSS/GPS/GLONASS have already been proposed and place additional restrictions on MES operations.

- Service operation procedures with regard to MES units to protect the Radio-Astronomy Service have already been proposed.

- The MES channel bandwidth of the TDMA or CDMA MES signal will have a direct effect on the spread of the out-of-band emissions.

- Some CDMA signals may be wider than GLOBALSTAR's 1.23 MHz channel

- The IS-95 Emission Limitations are more stringent than those existing in 25.202(f) and should be sufficient to protect primary uplink services in adjacent bands.

- There is no justification to impose stringent emission limitations on MES units operating in a primary allocation to protect a secondary service. Secondary downlink services cannot claim protection from harmful interference of a primary service.

## SECTION 2

## 2.0 Interservice Sharing

## 2.1 Sharing with Radio Astronomy Service

### 2.1.1 Reply to Comments by the Committee on Radio Frequencies and Observatories

LQP has studied the rule modifications proposed by the Committee on Radio Frequencies (CORF) concerning potential interference into the Radio-Astronomy Service (RAS) from MSS systems. In general, LQP agrees with CORF's modifications to the proposed Sections 25.213 (a) (i) through (viii). However, in order for there to be sufficient spectrum to locate transmissions from the Mobile-Earth Stations (MES) that are within the proposed RAS protection zones, the CDMA MSS systems will require L-Band spectrum from 1610 MHz to at least 1620.1 MHz. This will allow MSS operators to have a range of frequencies in which to accommodate users consistent with the MSS frequency channelization plans. For GLOBALSTAR, it will also allow a user who is geographically close to an RAS site to have a channel assignment where the intermodulation products of the MES will be above 1613.8 MHz, and thus lower the potential chance of interference into the RAS site. By increasing the available spectrum to at least 1620.1 MHz and preferably to 1621.35 MHz, there would be a choice of two or three channel frequencies on which to operate. For other CDMA MSS systems with wider channel bandwidths, sufficient L-band spectrum must also be available in which to assign users located in proximity to RAS sites.

In keeping with its comments, LQP suggests a modification to CORF's proposed Rule 25.231 (1) (v) as follows:

> *(v) The EMSU shall maintain a current schedule of the periods and locations of radio astronomy observations in the band 1610.6 - 1613.8 MHz. The schedule shall be available, preferably in computer readable format, for consultation by MSS system operators. The mobile-satellite system shall be capable of preventing the operation of mobile Earth stations within the protection zones as specified in (i), (ii), or (iii) above, on any frequency in the 1610.6 - 1615.8 MHz band after the first position fix of the mobile terminal either prior to transmission or based upon its location being within the protection zone at the time of initial transmission of the mobile terminal.*

LQP has studied the comments of Cornell University, which operates the Arecibo Observatory in Puerto Rico, on the protection of the 1610.6 - 1613.8 MHz